National Park Service
U.S. Department of the Interior

Air Resources Division

PORTABLE OZONE MONITORING STATION (POMS)
OPERATOR'S GUIDE

Prepared by

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PORTABLE OZONE MONITORING STATION (POMS)

1.0 OVERVIEW

The portable ozone monitoring station (POMS) continuously measures ambient ozone concentrations, wind speed and direction, air temperature, relative humidity, solar radiation, and precipitation. Some stations may also have a Clean Air Status and Trends Network (CASTNet)-style filter pack sampler and barometric pressure sensor. The station operates on low power (battery-supplied 12 volts DC) which is recharged with either solar panels or 120 VAC. Data are collected hourly via a satellite modem or daily, using a telephone modem by Air Resource Specialists, Inc., for validation and reporting. Data are also stored on-site within a removable storage module in case of data transmission problems.

Two portable station configurations were developed. The original station, known as the Platform POMS (see Figure 1-1), uses a platform with 20-foot tipping tower. The ozone inlet is mounted at the top of the tower. This station includes two 2B Technologies, Inc. ozone monitors or one ozone monitor and one ozone calibrator. Some of these systems also have CASTNet flow filter packs and barometric pressure sensors.

The second portable station configuration, known as the Tripod POMS (see Figure 1-2), is mounted on a smaller, lightweight tripod. This station configuration uses only one 2B Technologies, Inc. ozone monitor. To minimize weight and cost, a smaller solar system or AC line power is used to power this system. The smaller solar system is not adequate to power the CASTNet flow filter pack system, therefore CASTNet filter packs cannot be implemented on this tripod system.

Operation of the platform and tripod stations is essentially the same. Both types of stations operate unattended; however, weekly station checks are recommended for filter changes and quality assurance checks.

Figure 1-1. Platform POMS.

Figure 1-2. Tripod POMS.

2.0 WEEKLY STATION CHECKS

Weekly station checks include completing the monitoring checklist, exchanging the ozone inlet filters, replacing the storage module (if necessary), and forwarding the checklist to the Operation Support Contractor (OSC).

2.1 Complete the Monitoring Checklist

The checklist serves as a quality assurance document; actual conditions as observed by the site operator can be compared to the data collected and stored by the datalogger. To complete the checklist, the operator needs to be familiar with the Campbell Scientific Incorporated (CSI) 23X datalogger. Instantaneous values from the datalogger are accessible through the keypad and display.

Figure 2-1 is an example of a completed checklist. The operator completes the *Site, Date,* and *Operator* fields and then checks the datalogger time and date by pressing ***5** on the keypad. The time displayed should be the current local standard time no matter what time of year it is. Standard time is used for all air quality and meteorological measurements year-round, and is one hour less than daylight time. Record the datalogger time. Press **A** (advance) to display the year and record on the checklist. Press **A** again to display the Julian Day; record on the checklist. The operator should verify that the datalogger date and time are within 5 minutes of actual time using a timepiece recently set using WWV (1-303-499-7111). Should the datalogger be more than 5 minutes off, reset the time by pressing **A** again (the time will be displayed) and entering the correct standard time using the numeric keypad. Press **A** twice more to complete setting the time. The datalogger should be able to maintain the correct time within 1 minute per month, and should not need frequent adjustment.

There are three ozone configurations: 1) single ozone monitor, 2) double ozone monitor, and 3) ozone monitor and calibrator with flow. Determine which of the three configurations you have and record the values only for the column of the configuration you have on the checklists. Ignore the other columns on the checklists.

The values are viewed from the datalogger's input storage locations, accessible by entering ***6** Continue to press **A** to advance to the next storage location, and record the values displayed. Compare the recorded value with your estimate of the current conditions and circle either **Y** or **N** to indicate if it agrees with expected values. Please add a comment if the value does not match the current conditions. Press **A** to advance to the next parameter (**B** to backup) and complete recording and comparing all the measured meteorological measurements. Not all stations have a Bar Press (barometric pressure) sensor and Flow (CASTNet-style filter pack samplers); these values will contain a *-999*.

Depending on your configuration, locations 9, 10, 11, and 20 through 24 refer to the 2B Technologies, Inc. ozone monitors. Ozone monitor TwoB_1 operates continuously; the value displayed on the datalogger should closely match the *Avg O3* = value displayed on the monitor. TwoB_2, used only on the platform systems with two ozone monitors, only operates between 11:30 and 13:01 each day (standard time); data for this monitor is only updated in the TwoB_2 display between 12:00 and 13:01. TwoB_1Zer, TwoB_2Zer, TwoB_1Sim, and TwoB_2Sim are the results of the most recent zero check (finishes at 11:56 each day) and simultaneous hourly average (finishes at 13:00 each day) of each 2B ozone monitor. Expect the corresponding zeros and spans to have similar values.

Air Resource Specialists, Inc.

Portable Air Quality Station
Meteorological Monitoring Checklist

Site DINO Date 4-19-07 Operator Scott Madsen

23X Time 12:48 (*5) LST Year 2007 (A) Julian Day 109 (A)

Time/Date within 5 minutes? YES / NO If no, Time/Date corrected? YES / NO

Press *6A, continue to press A to advance screen.

Single Ozone Monitor			Double Ozone Monitor with Flow			Ozone Monitor and Calibrator with Flow			Matches Expected Values?
01 Wind Speed		m/s	01 Wind Speed		m/s	01 Wind Speed	5.4	m/s	Y N
02 Wind Dir			02 Wind Dir			02 Wind Dir	255		Y N
03 Air Temp_1		°C	03 Air Temp_1		°C	03 Air Temp_1	10.4	°C	Y N
04 Rel. Humid		%	04 Rel. Humid		%	04 Rel. Humid	18.7	%	Y N
05 Solar Rad		w/m²	05 Solar Rad		w/m²	05 Solar Rad	780	w/m²	Y N
06 HR Precip		mm	06 Bar Press		mm Hg	06 Bar Press	634	mm Hg	Y N
07 Batt Volts (between 12-14)		vdc	07 HR Precip		mm	07 HR Precip	0.00	mm	Y N
			08 Batt Volts (between 12-14)		vdc	08 Batt Volts (between 12-14)	13.7	vdc	Y N
08 P Temp		°C	09 P Temp		°C	09 P Temp	14.2	°C	Y N
09 TwoB_1		ppb	10 TwoB_1		ppb	10 TwoB_1	53.9	ppb	Y N
10 TwoB_12er		ppb	11 TwoB_2		ppb	11 Calibrator	4.01	mvdc	Y N
11 Precip		mm	12 Flow		lpm	12 Flow	-0.0176	lpm	Y N
			20 TwoB1_2er		ppb	20 TwoBZero	0.2	ppb	Y N
			21 TwoB2_2er		ppb	21 TwoBC50	51	vdc	Y N
			22 TwoB_1sim		ppb	22 TwoBC100	96	ppb	Y N
			23 TwoB_2 sim		ppb	23 TwoBC150	145	ppb	Y N
						24 CalError	49.985	mvdc	Y N
O3 particle filter replaced?		Y N	O3 particle filter replaced?		Y N	O3 particle filter replaced?		Y N	- ORANGE FILTER
			Filter pack exchanged?		Y N	Filter pack exchanged?		Y N	- GREY FILTER

Observe number of asterisks (*) in upper left hand corner of 2B Ozone monitor display.
Circle number of asterisks observed. 0 1 2
(Asterisks indicate how many times pumps have automatically switched in ozone mode.)

Instruments, tower, cabling secure? YES / NO. If no explain: _____

Other comments: _____

Keep white copy in site notebook. Send/fax yellow copy to:
NPSAIR Data Coordinator, Air Resource Specialists, Inc.; 1901 Sharp Point Drive, Suite E; Fort Collins, CO 80525
Telephone: 800/344-5423 Fax: 970/484-3423

Portable AQ Station Checklist.doc (04/07)

Figure 2-1. Example of Completed POMS Meteorological Checklist.

Configurations with an ozone monitor and a calibrator automatically perform a multipoint ozone check each day at 08:00 local standard time. The results of this check are recorded in locations 20 through 24.

On the tripod systems, 2B_2 is not installed. Therefore all the datalogger channels corresponding to 2B_2 will read *-999*. These channels include TwoB_2, TwoBzer_2, and TwoBsim_2. The zero check will come on each day at 11:45 and continue until 12:00.

2.2 Exchange the Ozone Inlet Filters

Each 2B ozone monitor has a particulate filter housed in a small, orange filter holder, located in the platform's "pothead" or in the 2B enclosure. The filter should be replaced weekly. Replace the filters by following the three steps below:

1) Mark each ozone monitor offline by toggling flags 7 and 8 (TwoB_1 and TwoB_2 offline) by selecting ***6AD** on the datalogger. Press digits **7** and **8** to alert the datalogger that maintenance is being performed on those systems. This should be done anytime ambient data are not being collected. Observe a *1* in positions 7 and 8 on the datalogger display.

2) For systems using two ozone monitors, lower the sampling mast by removing the locking pins and crank it down using the winch. For single ozone monitor systems, open the ozone enclosure to access the filter holder.

3) Replace the filter in the filter holder by loosening the orange tightening ring and separating the two filter holder halves. Remove and discard the exposed filter. Using the provided tweezers, remove a new 5 micron Teflon filter from the envelope and install it into the housing. Reassemble the filter holder and tighten the orange ring. Be sure the orange ring is tight to prevent leaks.

2.3 Remove and Replace the CASTNet Filter Pack (if equipped)

Each filter has a chain-of-custody form to document the conditions and length of time the filter was exposed. Figure 2-2 is an example of a completed chain-of-custody form. The operator will record values on the form each time a filter is installed and removed. Because a replacement filter is installed in place of the existing filter each week, two forms will be used each week. The "Filter Pack OFF" column values will be recorded for the filter to be removed. The "Filter Pack ON" column values will be recorded on the new form that comes with the new filter. Step-by-step directions to complete the form follow.

Before changing the filter the tower should be tipped and flags 7 and 8 should be marked offline as described in Section 2.2.

1) Record the "Site", "Filter Pack ID Number", and "Scheduled ON Date" on the form.

2) Press ***** then **5** on the datalogger keypad to view the local standard time (LST) on the datalogger. Record the time on the "Time" row.

Air Resource Specialists, Inc.

CASTNet Filter Pack Checklist And Chain-of-Custody Documentation

Site DINO

Filter Pack ID Number 0710001-81 Scheduled ON Date 5-15-07 Tuesday

Parameter	DAS Location	Filter Pack ON	Filter Pack OFF
Date	---	5 / 15 / 07	5 / 22 / 07
Time (LST - hh:mm)	*5	13:42	15:29
DAS Flow (lpm) (pump off)	*6 12A	~~1.51~~ 0.01	0.01
DAS Leak Check * (pump on, no filter)	*6 12A	0.02	0.02
DAS Flow (lpm) (pump on, filter installed)	*6 12A	1.50	1.50
Rotometer (lpm) (pump on, filter installed)	---	1.50	1.50
Running Time (hours)	*6 18A	3921.1	3961.4
Operator Signature			

* Call ARS if the DAS Leak Check value is greater than 0.05 lpm than the DAS Flow (pump off) value.

Expected Return Shipment Date: 5-23-07

Comments:

Keep yellow copy in site notebook
Send white copy with filter pack to:

NPSAIR Data Coordinator
Air Resource Specialists, Inc.
1901 Sharp Point Dr. Suite E
Fort Collins, CO 80525
Telephone 1-800/344-5423
Fax 970/484-3423

ARS USE ONLY
Shipment Received From Site: Date: _____ By: _____

Expected Shipment Date to Laboratory: _____

CASTNet Filter Pack Checklist.doc (03/06)

Figure 2-2. Example Completed Chain-Of-Custody Form.

3) Press ***612A** on the keypad, and shut the pump off using the pump toggle switch. The current flow value in liters per minute (lpm) will be displayed. Record this on the "DAS [Data Acquisition System] Flow (pump off)" row.

4) Perform a leak check by removing the filter. When the filter is removed a valve in the quick connect fitting is closed, which allows a leak test to be performed. After the filter is removed, turn the pump toggle switch back on and wait approximately 3 minutes for the pump to pull all the air out of the system. The ball on the rotometer should slowly fall to zero or at very close to zero. Record the flow value from the flow channel as described in Step 2 in the "DAS Leak Check" row. If the flow value is greater than 0.05 lpm, a leak is likely in the system. Contact ARS to resolve the leak.

5) Reinstall the existing filter by pushing it into the quick connect fitting until you hear a click. Wait approximately 30 seconds for the flow to stabilize. Record the flow value from the flow channel again as described in Step 2.

6) Record the rotometer flow in the rotometer row. The rotometer values are read from the center of the ball.

7) Observe the run time counter by pressing ***618A** on the datalogger keypad. Record the values in the "Running Time" row on the form. Each week the difference in the run time should be approximately 24 hours per day x7 days per week or 168 hours. For example, if the run time counter value when the filter was installed has 324, the value should be near 492 when the filter is removed seven days later.

8) Remove the filter pack from the pothead by pushing down on the quick connect fitting. The filter pack will pop out. Place the filter in the return tube and ship it to the lab to be analyzed. Insert the new filter into the pothead by pushing it into the quick connect fitting. A click should be heard to ensure the filter is secure.

9) Once the new replacement filter is installed, re-perform Steps 2 through 7 and record the values on the new chain-of-custody form that came with the filter.

10) Erect the mast to its original position and insert the locking pin.

2.4 Put the TwoB_1 and TwoB_2 Channels Back Online

This step is very important. Ambient ozone data will not be recorded if this step is not completed. Display the flag status again by pressing ***6AD on the** datalogger. Toggle flags 7 and 8 off by pressing digits **7** and **8** on the keypad. Observe *0*'s in positions 7 and 8 on the datalogger display. There should be a *1* in position 1 and 4 of the display (indicating Two_B1 and the filter pack flow is operating) and *1*'s in positions 2 and 3 depending upon the time of day.

2.5 Complete the Checklist and Fax or Mail to ARS

Indicate that the ozone particulate filters and the filter pack were exchanged on the checklist. Observe the condition of the support structures, cabling, and tubing, and note if any condition needs attention. Add any additional comments that will aid in the validation of the data, especially unusual events at the site. Example entries may include forest fire in the region, unusual rain or wind event since the last site visit, or any activity that might affect the measurement of the ozone monitor or meteorological sensors.

Keep the original white copy in the on-site notebook, and fax or mail the yellow copy to ARS. Call ARS with any questions or comments at 1-800-344-5423.

3.0 REMOVAL AND INSTALLATION PROCEDURES

To save costs and to increase reliability, the POMS units were not designed with sensor and power connectors, so removal or installation of a POMS by non-technical personnel may be difficult. Please assess your abilities and resources before attempting to dismantle or reinstall any POMS. This section attempts to guide the dismantling and reinstallation of a tripod POMS system. Selection of an appropriate monitoring location, orientation of the wind sensor, and calibration of the meteorological instruments is beyond the scope of this document. Dismantling or reinstallation of a platform POMS is not recommended.

Due to the size and shape of the systems, two people are required to remove or install a Tripod POMS system. Good mechanical aptitude and attention to detail is required for success. Careful labeling and good termination technique for both wiring and plumbing fittings is required. Warning; some parts are heavy, awkward, and sharp. Be careful to avoid injury or equipment damage.

For both disassembly and assembly of the portable ozone monitoring station, an assortment of hand tools are necessary which would include wrenches, pliers, screwdrivers, pry bar, hammer, pipe wrench, and socket set. A six-foot step ladder is also necessary for accessing the sensors attached to the upper part of the tripod tower and during installation, and a small torpedo level is useful in plumbing the tripod pole and final leveling of the rain gauge.

3.1 Disassembly and Removal

Refer to Figure 3-1 for specific component locations of the Tripod POMS.

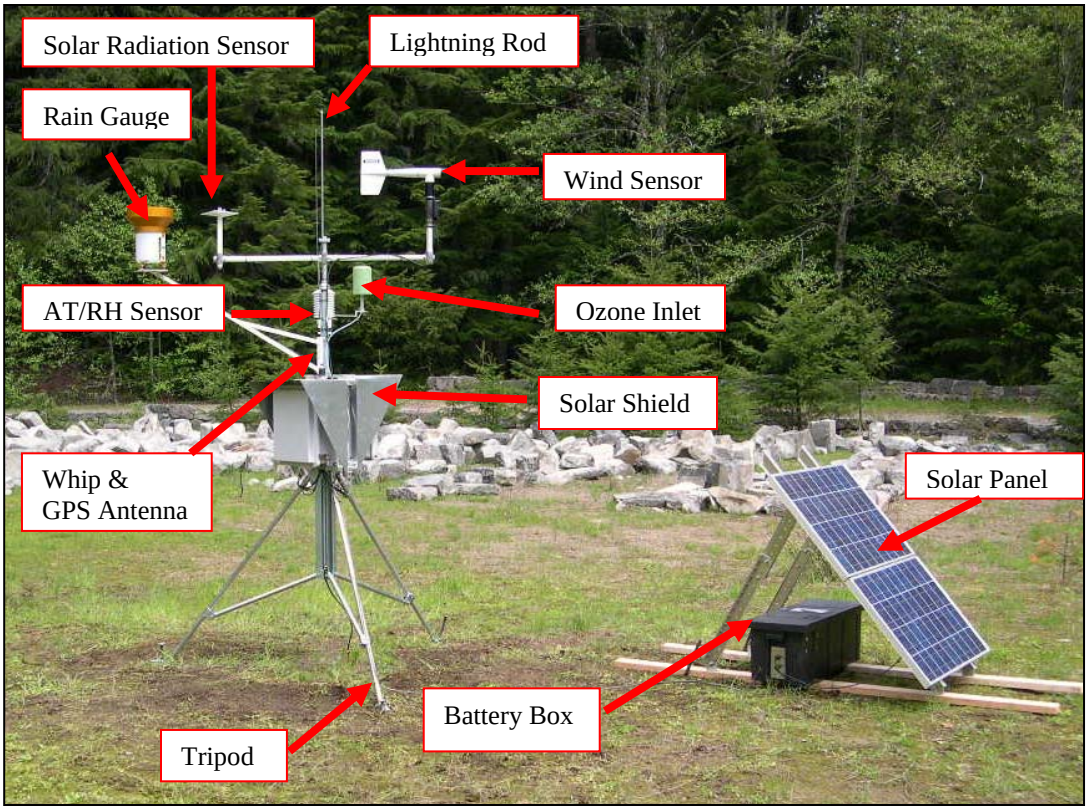


Figure 3-1. Annotated Photograph of the Tripod POMS.

3.1.1 Sensor removal

Before removing any wiring from terminations, label all wires with labeling tags according to appropriate designations on the datalogger, relay driver, power bus, solar controller, batteries, and solar panel junction boxes. Make sure any solar or power supply leads are temporarily isolated from each other with electrical tape to avoid accidental shorting of power systems before removing from power bus terminals. Remove the solar supply cable from the large lugs at the top and bottom of the black power bus, coil the cable, and store it inside the black battery box (refer to Figure 3-2).

Carefully remove all sensor wiring from the datalogger terminal buses, remove sensor wiring from inside of the datalogger environmental enclosure, and coil excess sensor wire. Remove the whip and GPS antenna cable from the Orbcomm transmitter. Remove individual sensors from their mounting locations, in some cases, with their mounting brackets attached. These sensors are attached to the pole with u-bolt hardware.

Next, remove the sensor crossarm assembly; remove the lightning rod from the vertical pole of the tripod, then loosen the Allen wrench set screws on the crossarm knuckle near the top of the vertical tripod pole. Finally, remove the crossarm.

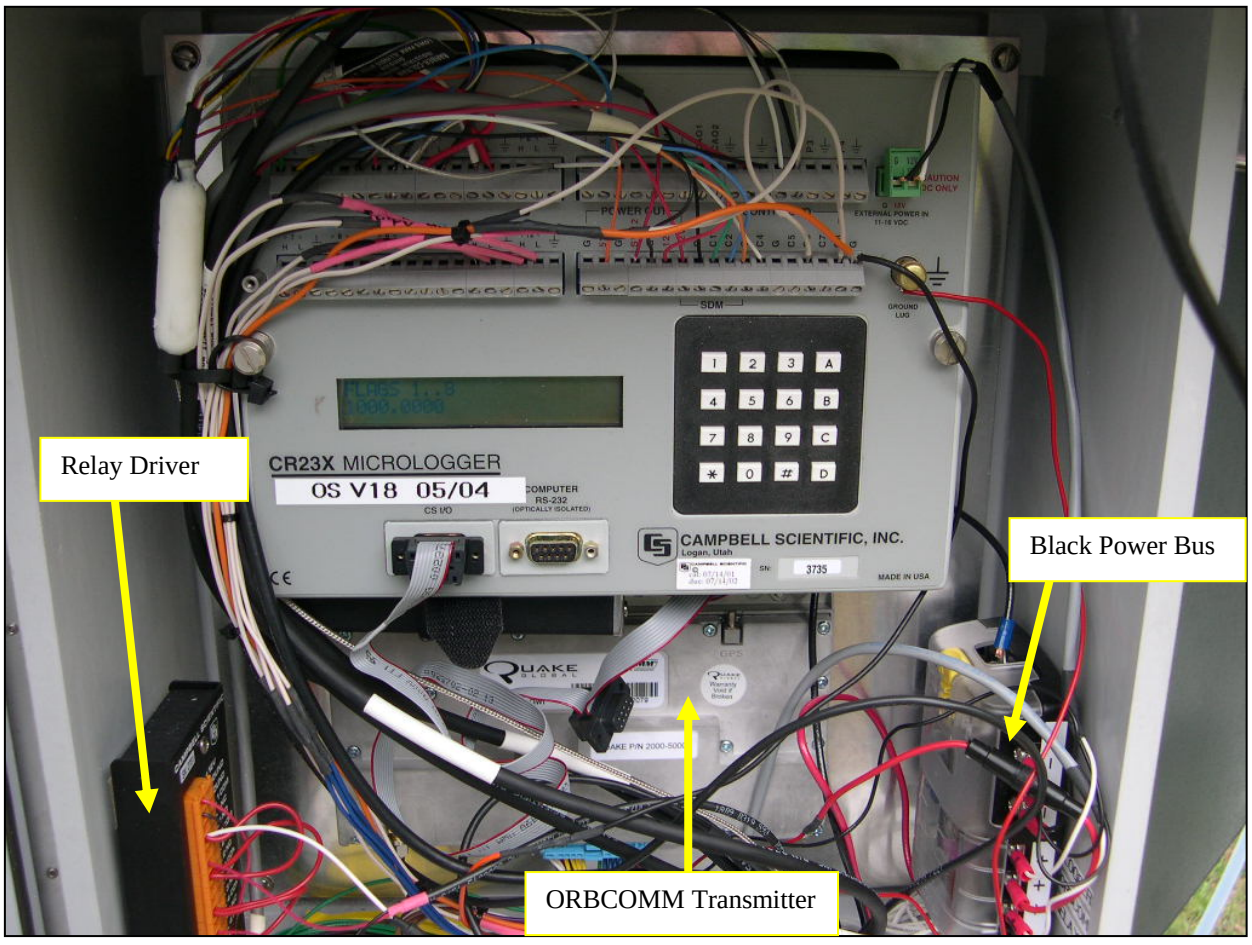


Figure 3-2. Datalogger Environmental Enclosure Components.

3.1.2 Ozone Inlet Removal

Remove the green ozone inlet assembly by removing its u-bolt. Then detach the Teflon tubing from the ozone monitor by unscrewing the Teflon nut assembly from the downstream side of the orange filter housing (see Figure 3-3).

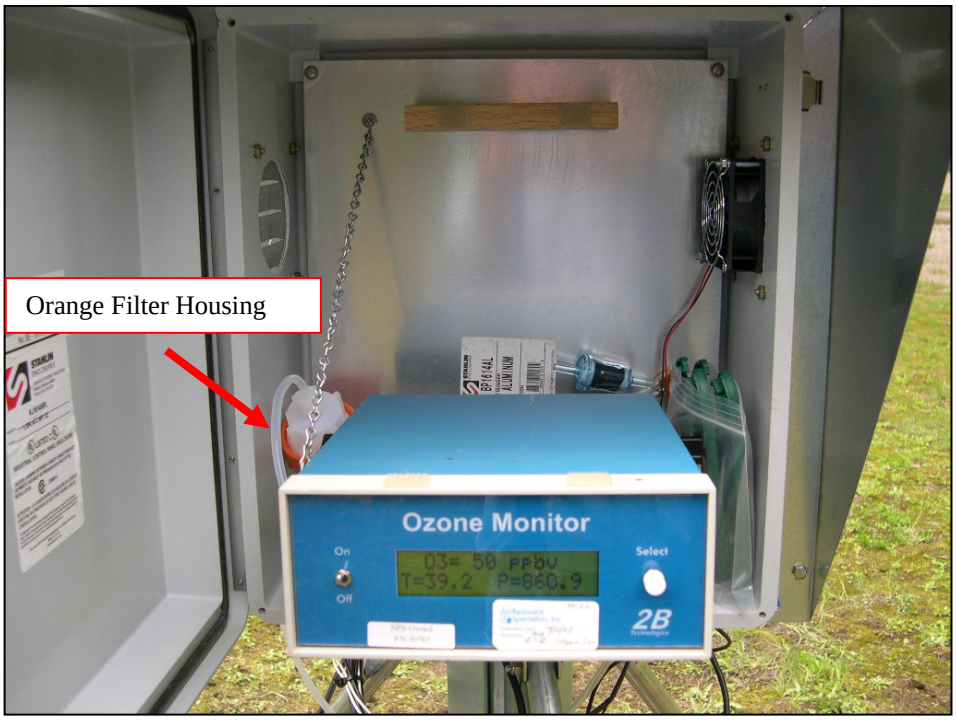


Figure 3-3. Ozone Monitor Enclosure.

3.1.3 Datalogger Box, Monitor Box, and Solar Shields Removal

Remove the gray plastic boxes, solar shields, and box brackets by unfastening the nut-bolt assemblies that secure these components to the vertical pole of the tripod. Four nut-bolt assemblies hold each box and solar shield to the box brackets.

3.1.4 Tripod Removal

Remove the lower lightning rod cable from the buried lightning rod stake at the exposed end of the stake. It may not be possible to retrieve the buried stake as some of them may be driven into the ground six to eight feet deep.

Each tripod leg is attached to the ground with a small stake that must be removed before the tripod feet can be collapsed. Remove each stake with a shovel or prybar, then loosen the clamping bolt at each lower tripod leg support. The legs can then be collapsed for transport.

3.1.5 Solar Panel and Battery Box Removal

The single cable connecting the battery box and solar panels can be temporarily disconnected from the battery box by removing this cable at the solar controller device mounted inside of the battery box. Remove this cable from the "battery +" and "battery -" terminals on the solar controller (temporarily tape the exposed end of the red wire with electrical tape to prevent damage to the solar panels). Remove the cable from the entrance fitting on the side of the large black battery box. Refer to Figure 3-4 for locations of cables and terminals.

Next, remove the battery box from underneath the solar panel assemblies, and detach the solar panel frames from the 2x4 assemblies at the feet of the solar panel frame assemblies. Collapse the solar panel frame arms tight to the back of the solar panel assemblies.

3.2 Assembly and Installation

Refer to Figure 3-1 for specific component locations of the Tripod POMS.

Before installing the tripod, make sure that your chosen location will not be shaded from direct sunlight by trees or other obstructions. The solar panels need plenty of direct sunlight to maintain a full charge on the batteries.

3.2.1 Tripod Installation

Spread all three legs of the tripod equidistant from the main tripod pole, so that the leg pads rest over the circumference of an imaginary circle approximately 6 to 8 feet in diameter. The vertical pole of the tripod needs to be plumb to the horizon, which can be checked with a level or plumb bob. By adjusting one or more leg braces, the tripod pole vertical alignment can be changed. Tighten the leg clamp support brackets with the clamping screw at each junction of the leg to the leg support, once the plumb of the main pole is achieved.

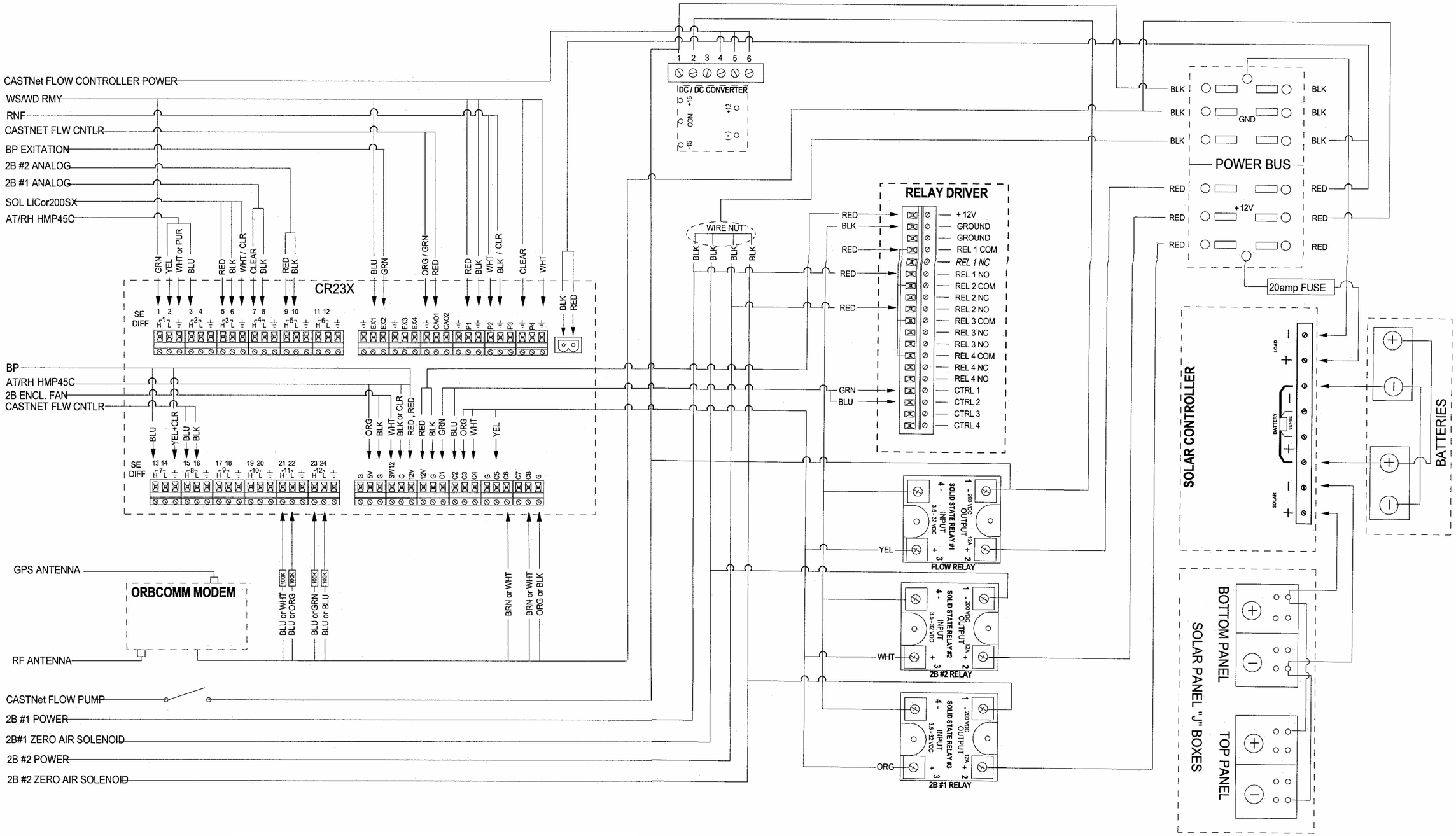
Drive the leg stakes into the ground through the hole in each of the leg pads. Next drive a copper ground stake into the ground, leaving four to six inches exposed above the ground. Attach the lower ground cable to the ground rod with a ground rod connector.

3.2.2 Datalogger Box, Monitor Box, and Solar Shields Installation

Two white box brackets should be installed onto the vertical pole already, back-to-back, so that the pre-drilled alignment holes match the holes at each corner of the two environmental boxes. The two galvanized solar shields need to be installed during this process, sandwiched between the environmental boxes and the white box brackets. These assemblies should be attached together with ¼ x 1¼ hex bolts, lock washers, and nuts.

WIRING SCHEMATIC
FOR
NPS PORTABLE OZONE MONITORING STATION

VERSION 1
(TWO 2B OZONE ANALYZERS)



Drawn By: Dave Meisters
Air Resource Specialist's, Inc.
N:\project\NPSAIR\DRAW\Wiring diagrams\POMS\POMSv1.FC7

Figure 3-4. Wiring Schematic of the Platform POMS.

3.2.3 Sensors and Ozone Inlet Installation

The white rain gauge arm can now be installed directly above the two solar shields with two u-bolts. The rain gauge installation is easier if the rain bucket is already attached to the white arm before installing it to the vertical tripod pole. After installing the arm, place a level across the top of the rain gauge, and adjust its feet to level the rain gauge.

Next, install the green ozone inlet hat assembly directly above the rain gauge arm. Feed the ¼ Teflon tube through the bottom access hole of the analyzer's environmental enclosure, and install the end of the tube onto the open end of the orange filter housing, by means of a ¼-inch Teflon nut. Make sure the tubing is secure to the one end of the orange filter housing by gently pulling on the tubing to make sure it does not slip out of the Teflon nut.

3.2.4 Sensor Wire Connections

Install the wind and solar radiation crossarm to the tower (sensors should already be attached to both ends before installing the assembly to the tower). This saves time by allowing you to attach the sensors at the ends of the crossarm while on the ground. Align the crossarm to true north/south, with the installed wind sensor in the north sensor mount and the solar radiation sensor in the south sensor mount. Install the wind sensor alignment collar with the notch to the south. Use an Allen wrench to tighten the crossarm to this alignment.

All sensor wires and ozone monitor box wires need to be fed through the entrance fitting of the datalogger environmental enclosure, and then terminate at the specified locations illustrated on the wiring schematic (Figure 3-4). Next, feed the whip and GPS antenna cable through entrance fitting and connect the whip antenna to lower left Orbcomm antenna jack and GPS antenna to upper right Orbcomm antenna jack. Refer to the schematic (Figure 3-4) for all wire designations, and locations to terminate wire ends. A small flat-bladed screwdriver is needed to terminate these sensor connections by means of terminal screw heads on the datalogger terminal buses, and the relay driver terminal bus.

Next, attach the air temperature/relative humidity sensor/solar radiation shield assembly directly above the ozone inlet mounting bracket by means of a u-bolt.

Finally, install the lightning rod and upper lightning rod cable to the tower. A special lightning rod terminal connector is already attached to the vertical tripod pole just above the upper leg brackets.

Use a torpedo level to recheck the vertical mast, rain gauge, and crossarm, and readjust as necessary.

3.2.5 Solar Panel and Battery Box Installation

Position two 2x4x8ft. boards parallel to each other so the distance between each other is the same dimension as the distance between the solar panel struts, so that the feet of the solar panel frames will rest on top of the 2x4s (see Figure 3-1). Both of these 2x4s (or similar length of metal angle) should be pointing to a general South direction, and should be placed in a location where nearby tree shadows will not interfere with direct sunlight over the face of the solar panels.

Drive two stakes into the ground at each end of each 2x4, so that the stake is touching the edge of the 2x4, then attach the stake to the 2x4 by means of appropriate fasteners. Next, set up the solar panel assembly over the 2x4s so that the legs support an angle of the solar panel faces of approximately 45^{o} to the horizon. Attach the solar panel feet to the 2x4 (or metal angle) by appropriate fasteners.

Next, position the solar panel battery box over the 2x4s or metal angle, to weigh down the solar panel assemblies (see Figure 3-1). Feed the loose cable coming from the solar panel junction box into the strain relief entrance at the side of the battery box, and connect the red wire to the solar controller terminal (mounted inside of the batter box) labeled “Battery +”. Then attach the black wire to the terminal labeled “Battery -”. A diagram of this connection is illustrated on the wiring schematic (see Figure 3-4).

Finally, the other cable leading out of the battery box (the cable that is connected to the solar controller terminal labeled “Load -” and the red wire connected to the 20-amp fuse) should be fed through the lower entrance fitting of the datalogger box, and its red wire connected to the main terminal of the power bus at the lug nut labeled +. Likewise, attach the black wire of this cable to the negative- lug of the power bus. See the wiring schematic, and pictures of the power bus inside of the datalogger environmental enclosure. These two wires (14 gauge, solid copper) should already have large spade lugs attached to the ends of the wires.

3.2.6 Relay Driver Wiring

Feed all wires from the ozone monitor environmental enclosure components through the entrance fitting of the datalogger environmental box and install the 2B ozone monitor’s +12v (red) power cable into the relay driver location labeled Rel 1 NO. See Figure 3-5 for reference.

Next, install the zero-air solenoid valve +12v (red) wire into the relay driver’s location labeled Rel 3 NO.

Finally, terminate the ground wires from both the 2B ozone monitor power wire and the ground wire from the zero-air solenoid valve to the ground wire from the power bus cable. Use an electrical wire nut to connect all three of these ground wires together. See the wiring schematic for the details of this description.

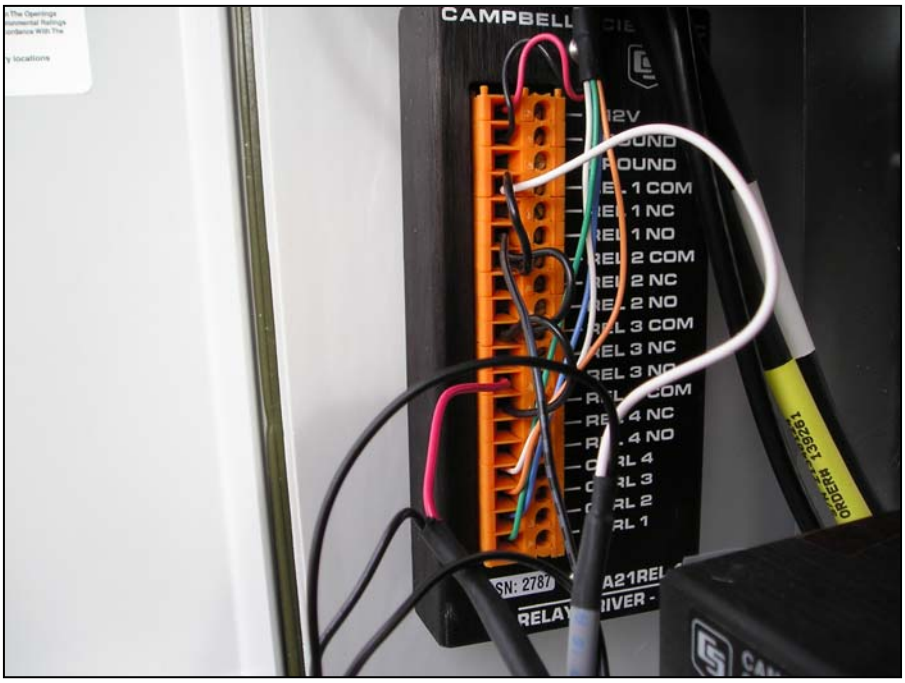


Figure 3-5. Relay Driver (Typical Wiring).

3.2.7 System Check

Review each sensor's output by viewing the instantaneous values from the datalogger. Select ***6A** from the datalogger keypad and increment through each parameter checking for reasonable response. Double-check sensor terminations if values appear incorrect.